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EXTINGUISHMENT AND BURNBACK TESTING OF FIRE FIGHTING AGENTS

Kimberly D. Barrett
Jennifer L. Kalberer
Applied Research Associates, Inc.
P.O. Box 40128
Tyndall AFB, FL 32403

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Air Force Research Laboratory
Materials and Manufacturing Directorate
Airbase Technologies Division
139 Barnes Drive, Suite 2
Tyndall AFB, FL 32403-5323

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14. ABSTRACT

The Air Force, in cooperation with the Federal Aviation Administration, is screening new fire fighting foam concentrates to determine their effectiveness at extinguishing and resisting burnback for hydrocarbon fuel fires. This report documents the evaluation performed on the fire extinguishing agents FLAMEOUT, FlameOut Foam and Hawk SUPER B in accordance with the parameters set forth in Military Specification (MIL SPEC) MIL-F-0024385F, Section 4.7.13 for the twenty eight square foot fire test using three percent of Type 3 foam (normal concentration). Under the MIL SPEC test protocol, agents were required to meet a maximum extinguishment time of 30 seconds and a minimum burnback time of 360 seconds for normal concentrations. None of the three agents tested at the normal concentration met these minimum requirements.

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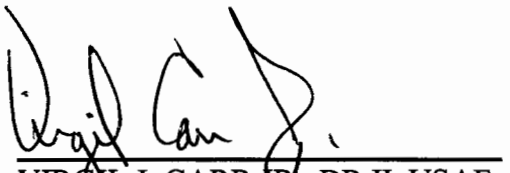
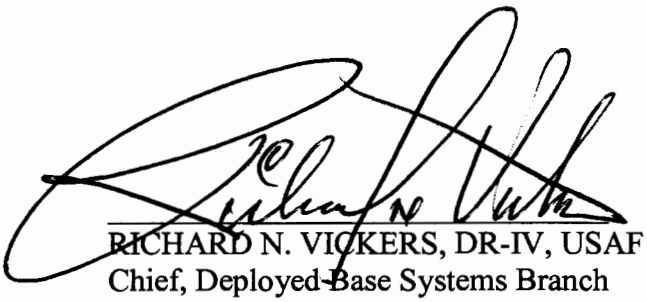


VIRGIL J. CARR JR., DR II, USAF
Leader, Fire Research Group



RICHARD N. VICKERS, DR-IV, USAF
Chief, Deployed Base Systems Branch

JIMMY L. POLLARD, Colonel, USAF
Chief, Airbase Technologies Division

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SUMMARY

The Air Force, in cooperation with the Federal Aviation Administration, is screening new fire fighting foam concentrates to determine their effectiveness at extinguishing and resisting burnback for hydrocarbon fuel fires. The DoD and FAA are interested in a simple, reliable test to evaluate the effectiveness of new foams being introduced into the market as potential Aqueous Film Forming Foam (AFFF) replacements. This report documents the evaluation performed on the fire extinguishing agents FLAMEOUT, FlameOut Foam and Hawk SUPER B in comparison with the performance of 3M AFFF in accordance with the parameters set forth in Military Specification (MIL SPEC) MIL-F-0024385F, Section 4.7.13 for the twenty-eight-square-foot fire test using 3% of Type 3 foam. The MIL SPEC test offers a screening method to determine the extinguishment and burnback characteristics of each foam in comparison to MIL SPEC AFFF. For an agent to pass the performance requirements, it must have a maximum extinguishment time of 30 seconds and a minimum burnback time of 360 seconds. Of the three agents tested, none met the 3 percent, Type 3 minimum requirements.

I. INTRODUCTION

A. *Background*

The Air Force, in cooperation with the Federal Aviation Administration (FAA), is screening new fire fighting foam concentrates to determine their effectiveness at extinguishing and resisting burnback for hydrocarbon fuel fires. Potential Aqueous Film Forming Foam (AFFF) replacements are required to exhibit an increased level of fire fighting effectiveness above current MIL SPEC AFFF. Because many new manufacturers of Class B fire fighting foams have entered the market, the Air Force and FAA are interested in a simple, reliable test to rule out those foams that do not meet minimum MIL SPEC requirements.

B. *Purpose*

This report documents the evaluation performed on the fire extinguishing and burnback properties of FLAMEOUT, FlameOut Foam and Hawk SUPER B in comparison with the performance of 3M AFFF in accordance with the parameters set forth in the MIL-F-0024385F, Section 4.7.13 for the twenty-eight-square-foot fire test.

C. *Scope*

This evaluation of the agent effectiveness on a Class B hydrocarbon fuel fire included the fire extinguishment time and, when possible, burnback time, using a three percent concentration. This testing was conducted as a screening method to determine the extinguishment and burnback characteristics of each new foam in comparison to MIL SPEC 3M AFFF. The complete 28 ft^2 fire test is comprised of 5 different tests including lean concentration with seawater and freshwater, normal concentration with seawater and freshwater and rich with seawater (Table 1). For an agent to successfully complete this requirement, all five components of the 28 ft^2 fire test must be passed. As a means to quickly screen agents, only the normal concentration with freshwater was tested.

Table 1. MIL SPEC AFFF Test Concentration Values and Fire Performance.

Solutions	Type 3	Type 6	Maximum Extinguishment Time (seconds)	Minimum Burnback Time (seconds)
Lean[1]	1.5 ± 0.03	3 ± 0.1	45	300
Normal strength[1]	3 ± 0.05	6 ± 0.1	30	360
Rich[2]	15 ± 0.2	30 ± 0.2	55	200

[1]One test with freshwater and one with seawater

[2]One test with seawater

II. METHODS

AFRL test protocol calls for performing a minimum of three tests per agent. The number of test can be altered based on the performance of the agent. These tests were conducted following the parameters and requirements set forth by Military Specification MIL-F-24385F, Section 4.7.13 for AFFF 3 percent, Type 3 (three parts

concentrate to ninety-seven parts freshwater) and compared to the performance of 3M AFFF. These tests were used only as a screening process to determine if the manufacturer should continue with the complete MIL SPEC test.

All tests were conducted inside the Air Force Research Laboratory Fire Hangar, Test Range II, Tyndall AFB, FL to minimize the effects of wind on testing.

A. *Equipment and Materials*

The equipment used during testing included a large circular pan (28 ft^2, ¼ inch thick stainless steel pan with a 4-inch high side) placed on a level surface, a smaller circular pan (1 foot, with a 2 inch side) to perform the burnback portion of the testing and a 2 gallon per minute (gpm) nozzle for foam application as specified in MIL-F-24385F, Section 4.7.5. The foam mixture was of normal strength for 3 percent, Type 3 made with freshwater. Ten gallons of unleaded gasoline, Mogas, which conforms to the American Society for Testing and Materials (ASTM) D439, was used during each test.

B. *Procedures*

Prior to each test, all equipment was cleaned, the nozzle was verified to disburse 2 gpm of foam and a layer of freshwater (1/4 inch deep) was placed in the bottom of the larger pan to guarantee complete coverage of the area with fuel. At the beginning of each test, ten gallons of fuel was poured into the larger pan within a 30 second period and the fuel was then ignited. After a 10 second pre-burn, the fire was attacked aggressively, with agent being first applied to the center and then to the outer edges to effectively coat and extinguish the flames. The exact moment of extinguishment was recorded and foam application continued for a total of 90 seconds, which ensured a consistent foam volume for all agents for the burnback test.

C. *Burnback Procedures*

Within 60 seconds of the completion of the foam application, the 1 foot pan containing 1 gallon of fuel was lit, placed in the center of the larger pan and the timer started. When the fire had spread outside the smaller pan and was burning steadily, the smaller pan was removed. The burnback time was recorded as the time when 7 square-feet (25 percent) of the total area were in flames. However, intermittent "flash-overs", characterized by creeping faint blue or invisible flames over the foam surface, were not considered part of the 25 percent of the total area. Burnback tests were only performed on agents that were able to completely extinguish the fire within the initial 90 second application time.

III. RESULTS

Each agent's performance was compared to the Military Specification performance requirements. The results of testing fell into 2 categories: extinguishment time and burnback time. Results from each agent are shown in Table 2.

Table 2. Summary of Test Results.

Agent	Percentage	Extinguishment Time	Burnback Time	Comments
Control Agent 3M AFFF	3%	0:38:00	Self Extinguished @ 551 sec	Small pan was not taken out
	3%	0:32:00	Self Extinguished @ 362 sec	
	3%	0:34:00	Not performed	Burnback test was not performed during this test
FLAMEOUT	3%	DNE	None Recorded	Did Not Extinguish
	3%	DNE	None Recorded	Did Not Extinguish
	3%			Test not performed per previous
FlameOut Foam	3%	DNE	None Recorded	Did Not Extinguish/ Agent application > 130 seconds
	3%	DNE	None Recorded	Did Not Extinguish/ Agent application > 130 seconds
	3%			Test not performed per previous
Hawk SUPER B	3%	DNE	None Recorded	Did Not Extinguish

A. ***Extinguishment***

The average extinguishment time for 3 percent, Type 3 3M AFFF was 34 seconds. During this test series none of the agents tested fully extinguished the fire, even though application of the agent continued for more than 90 seconds. In the case of Hawk SUPER B, the fire seemed to be further agitated by the application of the agent. Hawk SUPER B was only tested once due to the intense heat generated when applying the agent. This agent caused the fire to flare up and the firefighters could not safely maintain the close position to the pan necessary to conduct additional tests.

B. ***Burnback***

The control agent, 3M AFFF, self-extinguished after the pan was removed once the burnback fire was established. Self-extinguishment was determined to be the point when all flames from the burnback pan were extinguished. No backburn tests were performed on any of the 3 percent, Type 3 agents because the initial fire could not be extinguished.

C. ***Summary of Results***

For an agent to pass the performance requirements it must have a maximum extinguishment time of 30 seconds and a minimum burnback time of 360 seconds. FLAMEOUT, FlameOut Foam and Hawk SUPER B did not meet the minimum requirements for extinguishment and burnback at normal concentrations.

Reference: Military Specification MIL-F-24385F, Fire Extinguishing Agent, Aqueous Film-Forming Foam (AFFF), for Fresh and Sea Water, January 7, 1992.